



Designation: D 5083 – 96

Standard Test Method for Tensile Properties of Reinforced Thermosetting Plastics Using Straight-Sided Specimens¹

This standard is issued under the fixed designation D 5083; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This test method covers the determination of the tensile properties of thermosetting reinforced plastics using test specimens of uniform nominal width when tested under defined conditions of pretreatment, temperature, humidity, and testing-machine speed.

NOTE 1—Experience with this test method to date has been limited to glass-reinforced thermosets. Applicability to other materials remains to be determined.

1.2 This test method can be used for testing materials of any thickness up to 14 mm (0.55 in.).

NOTE 2—This test method is not intended to cover precise physical procedures. It is recognized that the constant-rate-of-crosshead-movement type of test leaves much to be desired from a theoretical standpoint, that wide differences may exist between rate-of-crosshead movement and rate of strain between gage marks on the specimen, and that the testing speeds specified disguise important effects characteristic of materials in the plastic state. Further, it is realized that variations in the thicknesses of test specimens that are permitted by these procedures, produce variations in the surface-volume ratios of such specimens, and that these variations may influence the test results. Hence, where directly comparable results are desired, all samples should be of equal thickness. Special additional tests should be used where more precise physical data are needed.

NOTE 3—Use of this test method for testing materials of thicknesses greater than 14 mm (0.55 in.) is not recommended. Reducing the thickness by machining may be acceptable for materials of uniform reinforcement amount and direction, but is generally not recommended.

1.3 Test data obtained by this test method is relevant and appropriate for use in engineering design.

1.4 The values stated in SI units are to be regarded as standard. The inch-pound units given in parentheses are for information only.

1.5 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

NOTE 4—This test method is technically equivalent to ISO 527-4 when

¹ This test method is under the jurisdiction of ASTM Committee D-20 on Plastics and is the direct responsibility of Subcommittee D20.10 on Mechanical Properties. Current edition approved July 10, 1996. Published September 1996. Originally published as D 5083 – 90. Last previous edition D 5083 – 95.

Note 4 was modified in this edition.

the Type 2 ISO specimen is used, except for the difference in the lengths of the specimens.

2. Referenced Documents

2.1 ASTM Standards:

D 374 Test Methods for Thickness of Solid Electrical Insulation²

D 618 Practice for Conditioning Plastics and Electrical Insulating Materials for Testing³

D 638 Test Method for Tensile Properties of Plastics³

D 883 Terminology Relating to Plastics³

D 3039 Test Method for Tensile Properties of Polymer Matrix Composite Materials⁴

D 4000 Classification System for Specifying Plastic Materials⁵

E 4 Practices for Force Verification of Testing Machines⁶

E 83 Practice for Verification and Classification of Extensometers⁶

E 691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method⁷

2.2 ISO Standard:

ISO 527 Part 4 Plastics—Determination of Tensile Properties—Test Conditions for Isotropic and Orthotropic Fibre-Reinforced Plastic Composites⁸

3. Terminology

3.1 *Definitions*—Definitions of terms applying to this test method appear in Terminology D 883.

4. Significance and Use

4.1 This test method is intended primarily as a quality-control test and as a screening test for fiber-reinforced laminates. It is particularly useful when the length of the reinforcement exceeds 12.7 mm (0.5 in.). Results obtained by this procedure may differ from those obtained by Test Methods D 638 and D 3039. In the case of disagreement, values

² Annual Book of ASTM Standards, Vol 10.01.

³ Annual Book of ASTM Standards, Vol 08.01.

⁴ Annual Book of ASTM Standards, Vol 15.03.

⁵ Annual Book of ASTM Standards, Vol 08.02.

⁶ Annual Book of ASTM Standards, Vol 03.01.

⁷ Annual Book of ASTM Standards, Vol 14.02.

⁸ Available from American National Standards Institute, 11 W. 42nd St., 13th Floor, New York, NY 10036.



obtained from Test Methods D 638 and D 3039 shall govern.

4.2 This test method is designed to produce tensile property data for quality control and research and development. Factors that influence the tensile properties, and should therefore be reported, are: material, methods of material and specimen preparation, specimen conditioning, test environment, speed of testing, void content, and volume percent reinforcement.

4.3 It is realized that a material cannot be tested without also specifying the method of preparation of that material. Hence, when comparative tests of materials per se are desired, the greatest care must be exercised to ensure that all samples are prepared in exactly the same way, unless the test is to include the effects of sample preparation. Similarly, for referee purposes or comparisons within any given series of specimen, care must be taken to secure the maximum degree of uniformity in details of preparation, treatment, and handling.

4.4 Tensile properties may provide useful data for engineering design purposes. However, because of the high degree of sensitivity exhibited by many reinforced plastics to rate of straining and environmental conditions, data obtained by this test method cannot be considered valid for applications involving load-time scales or environments widely different from those of this test method. In cases of such dissimilarity, no reliable estimation of the limit of usefulness can be made for most plastics. This sensitivity to rate of straining and environment necessitates testing over a broad load-time scale (including impact and creep) and range of environmental conditions.

NOTE 5—Since the existence of a true elastic limit in plastics (as in many other organic materials and in many metals) is debatable, the propriety of applying the term “elastic modulus” in its quoted generally accepted definition to describe the “stiffness” or stress-strain characteristics of plastic materials is highly dependent on such factors as rate of application of stress, temperature, previous history of specimen, etc. However, stress-strain curves for plastics, determined as described in this test method, almost always show a linear region at low stresses. A straight line drawn tangent to this portion of the curve permits calculation of an elastic modulus of the usually defined type. Such a constant is useful if its arbitrary nature and dependence on time, temperature, and similar factors are realized.

4.5 For many materials, there may be a specification that requires the use of this test method, but with some procedural modifications that take precedence when adhering to the specification. Therefore, it is advisable to refer to that material specification before using this test method. Table 1 of Classification D 4000 lists the ASTM materials standards that currently exist.

5. Apparatus

5.1 *Testing Machine*—A testing machine of the constant-rate-of-crosshead-movement type and comprising essentially the following:

5.1.1 *Fixed Member*—A fixed or essentially stationary member carrying one grip.

5.1.2 *Movable Member*—A movable member carrying a second grip.

5.1.3 *Grip*:

5.1.3.1 Grips for holding the test specimen between the fixed member and the movable member. The grips shall be self-aligning, that is, they shall be attached to the fixed and movable member, respectively, in such a manner that they will

TABLE 1 Tensile Strength at Break, psi, for Six Laboratories, Six Materials

NOTE 1—SMC = Sheet Molding Compound.

BMC = Bulk Molding Compound.

POLY = Polyester Resin/Glass Fiber Mat Reinforced.

PUL = Pultruded Ladder Rail.

CSM = Vinylester/Glass Fiber Mat Reinforced.

URE = Urethane Resin/Glass Fiber Mat Reinforced.

Material	Straight-Sided				
	Average	S_r^A	S_R^B	r^C	R^D
BMC	6125	580	784	1624	2197
SMC	9650	669	708	1875	1983
CSM	12 882	1431	1475	4009	4131
URE	16 491	844	844	2365	2365
POLY	17 784	1599	1599	4477	4477
PUL	81 868	1902	3188	5326	8927

^A S_r is the within-laboratory standard deviation of the average ((median/other function)).

^B S_R is the between laboratories standard deviation of the average ((median/other function)).

^C r is the within-laboratory repeatability limit = $2.8 S_r$.

^D R is the between-laboratories reproducibility limit = $2.8 S_R$.

move freely into alignment as soon as any load is applied, so that the long axis of the test specimen will coincide with the direction of the applied load through the center line of the grip assembly. Align the specimen as perfectly as possible with the direction of pull so that no rotary motion that may induce slippage will occur in the grips; there is a limit to the amount of misalignment self-aligning grips will accommodate.

5.1.3.2 Mount the test specimen in such a way that slippage relative to the grips is prevented insofar as possible. Grip surfaces that are deeply scored or serrated with a pattern similar to those of a coarse single-cut file, serrations about 0.09 in. (2.4 mm) apart and about 0.06 in. (1.6 mm) deep or finer, have been found satisfactory for most thermosetting materials. The serrations should be kept clean and sharp. Breaking in the grips may occur at times, even when deep serrations or abraded specimen surfaces are used; other techniques must be used in these cases. Other techniques that have been found useful, particularly with smooth-faced grips, are abrading that portion of the surface of the specimen that will be in the grips, and interposing thin pieces of abrasive cloth, abrasive paper, or plastic or rubber-coated fabric, commonly called hospital sheeting, between the specimen and the grip surface. Number 80 double-sided abrasive paper has been found effective in many cases. An open-mesh fabric, in which the threads are coated with abrasive, has also been effective. The use of special types of grips is sometimes necessary to eliminate slippage and breakage in the grips.

5.1.4 *Drive Mechanism*—A drive mechanism for imparting to the movable member a controlled velocity with respect to the stationary member, this velocity to be regulated as specified in Section 8.

5.1.5 *Load Indicator*—A suitable load-indicating mechanism capable of showing the total tensile load carried by the test specimen when held by the grips. This mechanism shall be essentially free of inertia lag at the specified rate of testing and shall indicate the load with an accuracy of $\pm 1\%$ of the indicated value, or better. The accuracy of the testing machine shall be verified in accordance with Practices